

Johanna Hansen, Queen's University, Kingston, ON, Canada
Troy Day, Queen's University, Kingston, ON, Canada

Coinfection, Competitive-Release and the Evolution of Resistance: A Mathematical Analysis

Experimental studies have shown that within-host competition between coinfecting strains can affect the growth and transmissibility of a strain. This in turn could have a serious effect on the emergence of resistant pathogens and their rate of spread through a population. However, when modeling the emergence and spread of drug resistance, the entanglement of coinfection has been mostly ignored.

We adapt the basic susceptible-infected model, to model the emergence of drug resistant pathogens under drug treatment pressure when there is coinfection. We are able to derive the invasion condition R_0 for a resistant pathogen under a coinfection framework thereby explicitly linking the emergence of drug resistance to the life history parameters of the pathogen and how they are affected through competition and drug action. This framework allows us to explore analytically the effect of competitive release on the emergence of resistant pathogens. We show that whether or not coinfection and competitive release promotes invasion depends on the relative values of the epidemiological parameters and thus the particular epidemiological cost associated with resistance.

Since we are also often interested in the growth of resistance once invasion has occurred we explore the rate of increase of resistance numerically. In addition, we can analytically estimate the growth of resistance when the coinfection efficiency is assumed to be small and determine whether coinfection will increase or decrease the rate of growth of resistance under this assumption.

We draw attention to the fact, that coinfection and competitive release play an important role in the emergence and growth of resistant pathogens. This phenomena could be a potential target to control drug resistance. By reducing the amount of competitive release or coinfection we could potentially have resistance emerge at a higher treatment rate, or grow at a slower rate. This could be achieved by potentially reducing the level of transmission, using drugs that target specific life stages where competitive release does not occur, or altering the dosage level of a drug.